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XAFS analysis of Fe, Mn, and Zn of an aeolian dust during transportation from China to Japan

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Introduction

Aeolian dust (Kosa) is transported from the arid or semi-arid region in East Asia to Japan during spring. A large particle of aeolian dust (>1 μm) mainly consists of mineral aerosol. Most elements originate in mineral aerosol. Some elements such as Cu, Zn, and Pb are rich in a small particle (< 1 μm). A small particle consists mainly of carbon aerosol, which is released by a vehicle, plant and heating system. We have studied chemical characteristics of aeolian dust during the transportation from China to Japan [1, 2]. The purpose of this study is to examine the variation of XANES spectra with change in the particle size and those during aeolian dust transport from China to Japan.

Materials

Aeolian dust sample was collected by Andersen-type low volume air sampler, which obtained the grain size distribution data of aeolian dust. A large-scale dust event was observed on 6-12 April 2002 in China and Japan [1]. The dust sample was collected in Beijing (China) and Fukuoka (Japan) during April 8 and April 6-11, respectively.

Experiment

The Mn, Fe, and Zn K-edge XANES spectra were recorded in the fluoresce mode at the BL12C of KEK-PF [3] under the atmosphere and at room temperature. The fluorescence X-ray was measured by a 19 element pure-Ge SSD [4].

Result and Discussion

Figure 1 shows some Fe XANES spectra of aeolian dust and reference materials. The Fe K-edge XANES spectra show that aeolian dust has the high Fe(III)/Fe(II) ratios (about 80-90%). This ratio slightly increases with increasing particle size. XANES spectra of dust sample collected at Beijing and Fukuoka stations are quite similar to one another. Therefore, the oxidation-reduction reaction during transportation of aeolian dust from China to Japan is negligible. On the contrary, CJ-1 and CJ-2, which are Chinese geological standard materials and represent of source materials for aeolian dust, have the different spectra from dust sample. They have smaller Fe(III)/Fe(II) ratios (about 60-70%) than dust sample. The oxidation reaction of Fe(II) in mineral aerosol may occur during early development of aeolian dust.

The Mn K-edge XANES spectra of aeolian dust obtained at two stations are similar to each other. The Mn(III)/Mn(II) ratio of aeolian dust increases with the decrease of particle size. The CJ-1 and CJ-2 have the different spectra from dust sample and higher Mn(III)/Mn(II) ratios. These results are just opposite to those of Fe K-edge spectra.

It is expected that Zn in the finer particle originates in a local anthropogenic material and it exists as $Zn(NO_3)_2$ and $ZnSO_4$. The Zn K-edge XANES spectra, however, do not severely change throughout the particle size and have the different features from those of $Zn(NO_3)_2$ and $ZnSO_4$. The Zn K-edge XANES spectra of dust samples rather have similar patterns to those of CJ-1 and CJ-2 irrespective of their particle sizes. Moreover, there are no significant differences of Zn spectra between Beijing and Fukuoka stations. Accordingly, Zn in aeolian dust originates in mineral aerosol and does not react with NO_3^- and SO_4^{2-} during the early development or during the transportation.

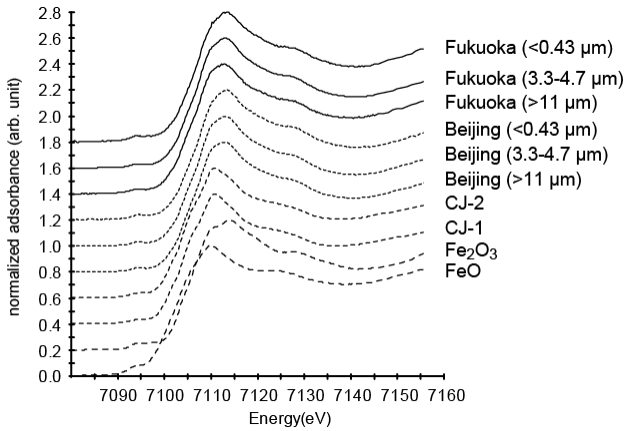

Figure 1. Fe K-edge XANES spectra of FeO, Fe_2O_3, CJ-1, CJ-2, and aeolian dust samples collected at Beijing and Fukuoka.

References

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